



# The Oceanography Report



The Oceanography Report  
The focal point for physical, chemical, geological, and biological oceanography.

Editor: Arnold L. Gordon, Lamont-Doherty Geological Observatory, Palisades, NY 10964 (telephone 914-359-2900, ext. 325).

## Information Report

### Symposia on Chemical Oceanography

A continuing concern of the National Science Foundation (NSF), the Office of Naval Research (ONR), and the National Oceanic and Atmospheric Administration (NOAA) is the effective utilization of young scientists. To this end, these agencies are interested in becoming more familiar with the ideas being formulated by these individuals as they enter the field of oceanography and independently pursue their research interests. It is also felt important that these new graduates be in possession not only of the most recent information on the research climate and opportunities in their respective fields, but are provided an insight into the structure, missions, and modes of operation of the sponsoring agencies of the symposia, as well as the procedures to follow in seeking support to conduct research from these agencies. As a result, the Marine Chemistry Program of NSF and the Chemical Oceanography Program of ONR were extremely receptive to a suggestion made in October 1976 by E. D. Goldberg of the Scripps Institution of Oceanography that it would be useful to have a symposium convened which would be completely dedicated to soon-to-be or recent Ph.D. graduates in chemical oceanography. After discussions at some considerable length with members of the scientific community, preparations were set in motion for convening such a meeting, which was anticipated to be the first in a series.

Owing to the fact that the symposia were created for and are completely dedicated to the newest Ph.D.'s in chemical oceanography, certain general guidelines were formulated. First, major professors of the participants and their departmental heads and deans would not be invited to attend the meeting. The reason for this was that we did not wish to run the risk of creating any barrier to open and frank discussions of papers being presented or to risk achieving the goals of the meeting by its being taken over by these individuals. Second, participation was limited to ensure that each participant had ample time to present his or her thesis research and that sufficient time was available for in-depth discussion and debate. Third, application to and selection for the meeting would be made on the basis of an extended abstract. These abstracts are to be printed in final form approximately 1 month after the close of the symposium, providing an opportunity for the authors to make any revisions as a consequence of the discussions that took place during the meeting. These abstracts are available from the cosponsoring agencies. Finally, time would be made available to the participants not only to initiate and hold informal sessions, but also to address certain topics raised by the agencies at the opening session. The results of these informal sessions would be presented by spokespersons of the groups formed to address the assignments.

It was felt that by bringing together, in scientific discussion and interaction, late stage chemical oceanography doctoral candidates, as well as new Ph.D.'s, professional relationships would be forged which would facilitate future interdisciplinary and interinstitutional investigations. It was also considered that the entire oceanographic community would become better aware of innovations in marine chemistry as a consequence of making young workers' efforts more visible. On the basis of the various types of data from the respective programs involved, these objectives have been realized, and it may well prove to be rewarding to consider having similar symposia convened in the other subdisciplines comprising the Ocean Sciences.

The first Dissertations Symposia on Chemical Oceanography (DISCO) was convened in

February 1978, jointly supported by NSF and ONR. Subsequent to the first meeting, NOAA joined in cosponsoring the symposia, which have been convened at approximately 18 month intervals, with coordination being provided in all instances by the American Institute of Biological Sciences (AIBS).

The fifth symposium was recently completed on March 9, 1984, and, again, was a complete success as viewed from both participants and sponsors who attended. With the conclusion of this latest meeting, a total of 139 young marine scientists representing 27 U.S. institutions have had the advantage of participating in, and receiving the benefits of, these symposia. In discussing the desirability of continuing these meetings with the community at large, which obviously included former participants, the present enthusiasm is greater than at the beginning in 1978, and it is clear that these meetings are a community service.

During the period of these symposia, we have benefited from having 10 foreign participants, representing five countries (Belgium, France, Japan, Norway, and Pakistan). Travel for these participants has been provided by both their national resources and the International Association for the Physical Sciences of the Ocean (IAPSO) has indicated that as an international scientific body they would be pleased to become associated with these meetings, and efforts have been initiated to obtain resources from an international organization to support foreign participation. In addition to the national resources noted above, indeed, it would seem that this series of symposia is proving to be of value well beyond that initially envisaged.

The sixth DISCO is now being planned and is anticipated to be convened from October 14 to 18, 1985. To be an invited speaker at the symposium, the applicant should have received his or her doctorate from an accredited university after October 1984 or, alternatively, his or her departmental chairperson or college dean must certify on the application form that in all probability the applicant will receive his or her degree before July 31, 1986. The applicant's thesis must deal with an important problem in chemical oceanography.

Potential participants are urged to note the dates of this meeting and be alert to a further announcement which will appear in the scientific literature and the posting of information concerning obtaining applications, which will be given wide distribution to appropriate graduate schools.

This Information Report was contributed by Neil R. Andersen, National Science Foundation, Washington, D.C. 20550, and Frank L. Herr, Office of Naval Research, Washington, D.C. 20350.

## News & Announcements

### Research Ship Plans for 1985-1987

The University National Oceanographic Laboratory System (UNOLS), representing operators of American academic research ships, has established a National Expeditionary Planning Committee to coordinate planning of research ship cruises to remote areas, multi-ship operations, and operations requiring fixed schedules of work. One essential part of this is to provide predictions of the areas in which the major research ships are likely to operate to make it possible for scientific investigators to do their own planning. This is, of course, a circular process: Some marine scientists have told us of their plans; these have resulted in tentative schedules. We hope that other investigators will fit their plans into these schedules to use the ships more efficiently and to avoid unproductive transit time.

In the following list, ships are listed as working in their "normal operating area," areas close to home port if there are not present plans for them to work elsewhere. Generalized routes are given for those ships for which there are plans for remote operations. All plans are of course subject to change. Scientific investigators interested in working on any of these ships should contact the ship-operating institution or the UNOLS office (William D. Burbee, UNOLS Office WB-15, School of Oceanography, University of Washington, Seattle, WA 98195).

**R/V Knorr (Woods Hole):** Normal operating area (north and equatorial Atlantic) during summers of 1985 and 1986. Work in far south Atlantic during winter of 1985-1986; may return north either through the Atlantic or the western Indian Ocean and Mediterranean. Time available for work en route in 1985 and 1986.

**R/V Melville (Scripps):** Normal operating area (northeast and central Pacific) 1985 through November and summer of 1986.

Possible meridional transects to and from Antarctica along 100° and 170° west in early 1986. Work in southern ocean (Atlantic and Pacific) in winter of 1986-1987, with transit runs either through eastern Pacific or south Atlantic.

**R/V Atlantis II (Woods Hole):** Northeast Pacific in early 1985. Atlantis II will carry the DSRV Alvin through 1985; its schedule is therefore tied to the Alvin schedule, which is not yet firm beyond the end of 1984. Atlantis II will be equipped with a SeaBeam system during 1985.

**R/V Conrad (Lamont):** Will work in the equatorial Atlantic and Caribbean in early 1985, followed by East Pacific Rise work into San Diego by June. Transit to the western Pacific (Philippines, South China Sea) and Indian Ocean (north Australia) will be followed by availability in Indian Ocean or southern Indian-Atlantic ocean in late 1985 and early 1986. A tentative schedule for further work in the Indian Ocean during mid-1986 will await proposals. Conrad is principally outfitted for marine geophysical programs, with SeaBeam and multichannel seismic system.

**R/V Thomas Washington (Scripps):** Starts 1985 in the south Atlantic; returns to eastern equatorial Pacific in May 1985. In fall-winter 1985 will probably make a loop via Hawaii to the southwest Pacific, to southeast Pacific. May return north in early 1986 through southeast Pacific for north Pacific operations. Will return south to Antarctica for the winter of 1986-1987. Equipped with SeaBeam; will carry two-channel digital seismic system for most of time.

**R/V Thomas Thompson (University of Washington):** Normal operating area (north Pacific north of about 25° north). Will work to Japan and back in 1985, has time available in the northwest Pacific.

**R/V Mauna Wave (Hawaii):** Will start 1985 off the coast of Peru, work off western South America in early 1985, transit via Easter Island across the South Pacific to the Fiji area in mid-1985. Will work in the western and southwestern Pacific through October and then proceed to the South Atlantic via either western South America or the Indian Ocean in November or December. Early 1986 will be spent in the southern ocean and a return to Honolulu via the Indian Ocean and southwest Pacific is planned for the summer and fall of 1986. Mauna Wave is being lengthened in 1984 and will carry a multichannel digital seismic system and SeaMARC II in addition to general laboratory areas and deep sea trawl and hydrographic winches.

**R/V Oceanus (Woods Hole):** Normal operating area (North Atlantic).

**R/V Endeavor (University of Rhode Island):** Normal operating area (North Atlantic). In 1985 will work between Equator and Iceland. In 1986 may work part of year in southeast Pacific.

**R/V Columbus Iselin (University of Miami):** Normal operating area (western North Atlantic, Gulf, and Caribbean).

**R/V Cyre (Texas A&M):** Normal operating area (western North Atlantic, Gulf, and Caribbean).

**R/V Horizon (Scripps):** Normal operating area (eastern north Pacific, California to Mexico).

**R/V Wetona (Oregon State University):** Normal operating area (northwest coast of United States). Will work south to Peru and back in March-April 1985.

This news item was contributed by George Shaw, Jr., Chairman, UNOLS National Expeditionary Planning Committee, University of California, San Diego, Scripps Institution of Oceanography, La Jolla, CA 92093.

### Symposium on Vertical Motion

A Symposium on Vertical Motion in the Equatorial Upper Ocean and Its Effects Upon Living Resources and the Atmosphere is to be held May 6-10, 1985, in Paris, France. This multidisciplinary international

symposium will address vertical motion in the equatorial upper ocean by bringing together leading researchers in oceanography, meteorology, and fisheries. Papers are invited with in the following topics: (1) generation, maintenance, and dissipation mechanisms of vertical motion; (2) relationship between changes in vertical motion and upper ocean heat content, sea surface temperature, and atmospheric planetary boundary layer variations; (3) instrumentation, observational techniques, and data analysis methods; (4) relationship between vertical motion and nutrient enrichment, biological productivity, and fisheries yield; (5) coastal upwelling in low-latitude regions; (6) the role of vertical motion in the 1982-1983 El Niño Southern Oscillation event; and (7) the relationship between vertical motion and the distribution of chemical properties.

This symposium is organized by the Scientific Committee on Oceanic Research (SCOR) Working Group 96 and is cosponsored by the Intergovernmental Oceanographic Commission (IOC), SCOR/IOC Committee on Climatic Changes and the Ocean (CCCCO), and Division of Marine Sciences of the UN Educational, Scientific, and Cultural Organization (UNESCO). Members of the Symposium Organizing Committee are D. Halpern (Chairman), United States; R. Barber, United States; O. Guillen, Peru; D. Hu, People's Republic of China; R. Jimenez, Ecuador; A. Longhurst, Canada; H. Roitsch, Ivory Coast; and B. Voituriez, France. The language of the Symposium will be English.

Circular Number 1 was issued in March 1984, in which abstract, registration, and general information about the symposium is provided, can be obtained by writing to David Halpern, NOAA PMEL, 7600 Sand Point Way NE, Seattle, WA 98115.

### The Pacific and Its Influence

A specially equipped scientific research ship and an Orion P-3 instrumented aircraft will be dispatched to the equatorial Pacific Ocean this spring by the National Oceanic and Atmospheric Administration (NOAA) to conduct in-tandem studies of the ocean's influence on, and relationship with, the atmosphere. The NOAA ship *Researcher* will cruise the waters from Honolulu to Tahiti between May 14 and June 4, taking water and air measurements while the Orion aircraft samples the atmosphere overhead. After 3 weeks of data collection, scientists hope to gain new knowledge about how the ocean is involved in such phenomena as acid rain, El Niño, and the "greenhouse" buildup of carbon dioxide. The project will support a series of five in answer the question of why rain activity is as high as in the remote ocean as it is in some coastal areas, one of these experiments will investigate concentrations of sulfur and other chemicals in the water column and at the atmosphere's boundary with the ocean. Another experiment deals with carbon dioxide and how it is transferred at the air-sea interface, a step in trying to understand the global "greenhouse" effect that is believed to be warming up the earth's climate.

Two more studies will gather data on trade winds in the equatorial zone and on the turbulent updrafts and downdrafts. The fifth heat across the air-water boundary. The fifth experiment is an investigation of the thermocline boundary layer that separates cold, oxygen-poor waters from the warmer waters above them.

These last two investigations will also feed data into NOAA's multi-year EPOCS (Equatorial Pacific Ocean Climate Studies) program, a broad effort by climatologists to understand the variation of sea surface temperatures in the tropical Pacific from season to season and from year to year. The hope is that this program will shed new light on global climate patterns and how they are occasionally disrupted by events such as last year's El Niño.

### NEW FROM AGU

### Magnetic Reconnection in Space and Laboratory Plasmas (1984)

Geophysical Monograph Volume 30  
Edited by Edward W. Hones, Jr.  
ISBN 0-87590-058-5 408 pages \$33

Write: American Geophysical Union  
2000 Florida Avenue, N.W.  
Washington, DC 20009

Call: 800-424-2488  
202-462-6903 (in DC area  
or outside contiguous USA)

Wire: Western Union  
Telex 710-822-8300  
Orders under \$50  
must be prepaid

AGU members receive  
a 30% discount



### News (cont. from p. 337)

intensity; deeper, stronger earthquakes; 2 seismic crises. Manam (Bismarck Sea): Strombolian jets, glowing avalanches, scoria flows. Langila (New Britain): Activity low; explosions at middle and end of month. Ulawun (New Britain): Explosions and January seismic crisis 3-month summary. Bagana (Solomon Is.): Sometes, glow, tephra emissions; but no new lava flows. Atmospheric Effects: Aerosols persist at mid-latitudes; sunset reports.

**Mauna Loa Volcano, Hawaii (19.47°N, 155.61°W):** All times are local (= UT-10 hours).

The following (except for the plume data) is from the USGS Hawaiian Volcano Observatory. Times noted below are preliminary and subject to slight revision after detailed analysis. The USGS will provide a more detailed report of the eruption for a future issue of EOS.

A Rank eruption began on March 25 and had ended by April 15. Simultaneous eruptions on March 30 at Mauna Loa, Kilauea, Mt. St. Helens, and Veniaminof make this the first date known on which four U.S. volcanoes were erupting at the same time.

Summit inflation had continued since Mauna Loa's last eruption July 5-6, 1975. Based on an increase in the rate of geodetic change and seismic activity, Decker et al. (EOS, September 13, 1983) called attention to the "increased probability of a Mauna Loa eruption within the next 2 years."

There was almost no short-term instrumental warning of the eruption. Seismic activity had been increasing gradually through March, but only 29 microearthquakes were recorded beneath the summit caldera in the 24 hours before the eruption (in contrast to 700 microearthquakes per day in September 1983). At 2255 on March 24, a small earthquake swarm began directly beneath the summit and weak harmonic tremor was recorded from the summit station at 2350. Tremor amplitude and the number of earthquakes increased about midnight, and borehole tiltmeters recorded the onset of rapid summit inflation at 0100.

A military satellite detected a "strong" infrared signal from the summit at 0125, and glow was sighted from the ground 4 min later.

## EOS

Transactions, American Geophysical Union

The Weekly Newspaper of Geophysics

For speediest treatment of contributions send three copies of the double-spaced manuscript to one of the editors named below and one copy to AGU.

**Editor-in-Chief:** A. F. Spilhaus, Jr.; **Editors:** Marcel Ackerman, Mary P. Anderson, Peter M. Bell (News), Bruce Doe, C. Stewart Gillmor (History), Clyde C. Goetz, Arnold L. Gordon, Louis J. Lanzetta, Robert A. Philney; **Managing Editor:** Michael Schwartz; **News Writers:** Barbara T. Richman; **News Assistants:** Tony Reichardt; **Production Staff:** Dae Sung Kim, Patricia Lichello, Lisa Lichtenstein, Cynthia T. McManigal.

**Officers of the Union:** James A. Van Allen, President; Charles L. Drake, President-Elect; Leslie H. Merdith, General Secretary; Carl Kisslinger, Foreign Secretary; J. Tuzo Wilson, Past President; A. F. Spilhaus, Jr., Executive Director; Waldo E. Smith, Executive Director Emeritus.

For advertising information, contact Robin E. Little, advertising coordinator, at 202-462-6903 or toll free at 800-424-2488. Advertising must be informative and consistent with the scientific and educational goals of AGU and is subject to approval

by AGU. Advertisers and their agents assume liability for all content of their advertisements and for any claims arising therefrom against the publisher. Offers in advertisements are subject to all laws and are void where prohibited.

Copyright 1984 by the American Geophysical Union. Material in this issue may be photocopied by individual scientists for research or classroom use. Permission is also granted to use short quotes and figures and tables for publication in scientific books and journals. For permission for any other uses, contact the AGU Publications Office.

Views expressed in this publication do not necessarily reflect official positions of the American Geophysical Union unless expressly stated. Subscription price to members is included in annual dues (\$20 per year). Information on institutional subscriptions is available on request. Second-class postage paid at Washington, D. C., and at additional mailing offices. *Eos, Transactions, American Geophysical Union* (ISSN 0096-9941) is published weekly by

American Geophysical Union  
2000 Florida Avenue, N.W.  
Washington, DC 20009

Cover. Magnetic reconnection is a process, important in systems of magnetized plasmas, by which differently directed field lines link up, allowing topological changes of the magnetic field to occur, determining patterns of plasma flow, and resulting in conversion of magnetic energy to kinetic and thermal energy of the plasma. The cover figure demonstrates quite similar consequences of magnetic reconnection that are found in the vastly different environments of a comet, earth's magnetosphere, and a laboratory fusion experiment. (Top) Yerkes Observatory photographs of Comet Morehouse before and after its plasma tail was severed by magnetic reconnection near the comet's head in what is called a "disconnection event" (DE). A comet's plasma tail is created by an accumulation of solar wind magnetic field lines that drape around the comet's head. In a DE, the solar wind plasma and energy that have been stored gradually in the tail during its generation are suddenly released and returned to the solar wind. (Middle) The plasma sheet (shaded) in the tail of earth's magnetosphere is suddenly severed near the earth by magnetic reconnection. This creates a plasmoid (a system of closed magnetic loops) that flows rapidly away through the tail, carrying a vast amount of plasma and

energy earlier acquired from the solar wind. Such episodes of plasmoid generation and release to the solar wind were dramatically confirmed by ISEE 3 satellite observations at 1.4 million kilometers from earth and are thought to be the underlying physical process in magnetospheric substorms. (Bottom) Axial cross section of the field-reversed 8-pinch experiment, FRX-C/T at the Los Alamos National Laboratory, showing translation of a field reversed configuration (FRC) from the left section of the cylindrical container, where it was formed, into the "drift tube" section at right. The FRC (shaded), a cylindrical plasmoid, was formed near Z = 0 m by magnetic reconnection when an initial B<sub>z</sub> (axial) field was entrapped in plasma and then compressed, at t = 0 μs, by a fast-rising B<sub>θ</sub> field of opposite sign (by courtesy of D. J. Rej, Los Alamos National Laboratory). In the middle and bottom panels the lines with black arrows are magnetic field lines and white arrows indicate the direction of plasma flow. (Further discussion of these phenomena can be found in *Magnetic Reconnection in Space and Laboratory Plasmas, Geophysical Monograph Series*, vol. 30, members \$25.00, nonmembers \$35.00; published by the American Geophysical Union.) (See Hones article in this issue.)

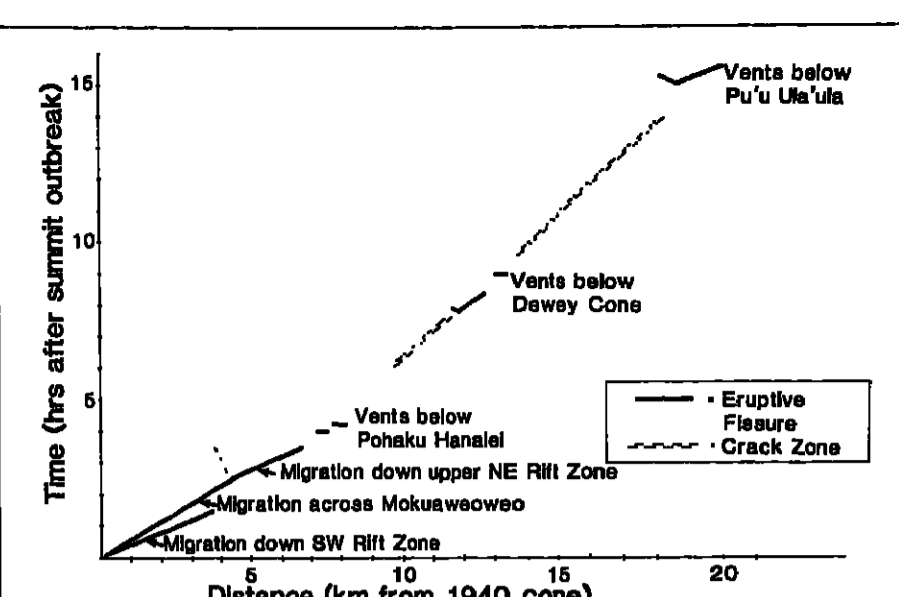


Fig. 1. Rate of propagation of eruption fissures, shown as distance from the 1940 cone (in the SW part of the summit caldera; see Figure 2) versus time in hours after the start of the eruption.

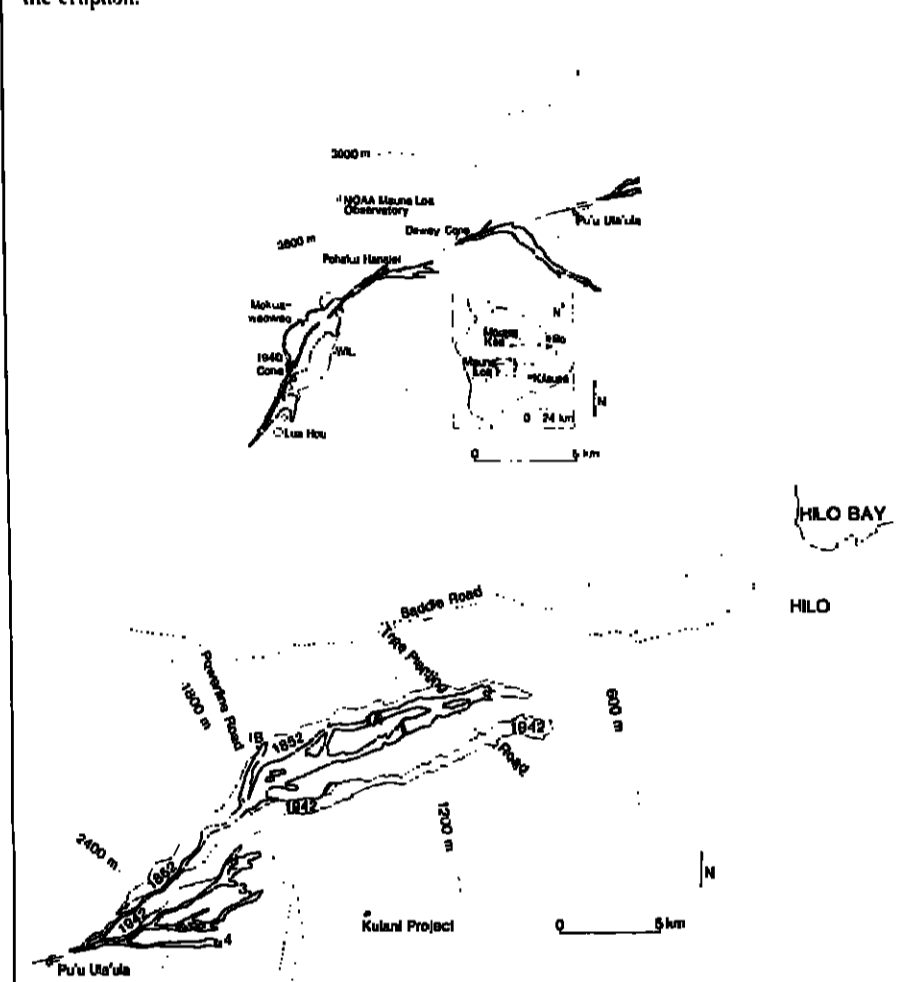


Fig. 2. Maps of the summit area and northeast rift zone of Mauna Loa. Eruption fissures are indicated by hatched lines and 1984 lava flows are stippled. Contours are approximately 600 m apart. The edge of the suburbs of Hilo is shown by a dotted line.

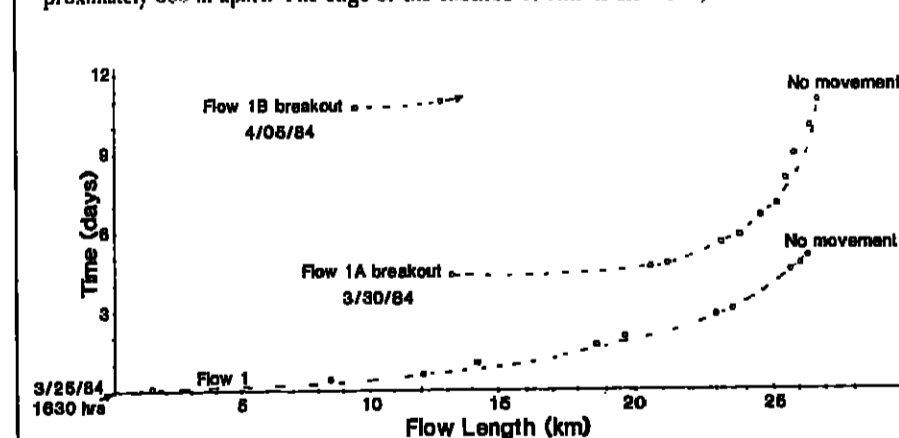


Fig. 3. Rate of movement of flows 1A, and 1B, in kilometers per day. Small circles represent observations of flow positions.

Phase 17 of Kilauea's east rift zone eruption began March 30 but had no apparent effect on Mauna Loa activity. Likewise, Kilauea tilt showed no deflection as the Mauna Loa eruption began March 25.

**Information Contacts:** J. Lockwood and staff, USGS Hawaiian Volcano Observatory, Hawaii Volcanoes National Park, HI 96718; J. M. Rhodes, Dept. of Geology, University of Massachusetts, Amherst, MA 01003; Michael Garcia, Dept. of Geology and Geophysics, University of Hawaii, Honolulu, HI 96822; Tom Casadevall, USGS Cascades Volcano Observatory, 5400 MacArthur Blvd., Vancouver, WA 98661; Arlin Krueger, Code 968, NASA Goddard Space Flight Center, Greenbelt, MD 20771; Michael Matson, NOAA/NESDIS, Room 510 World Weather Bldg., Washington, DC 20233.

**Fernandina Caldera, Galapagos Islands (0.37°S, 91.55°W):** All times are local (= UT-6 hours).

At 0500 on March 30, Oswaldo Chapi and Fausto Cepeda (of the Galapagos National Park) heard noise from Fernandina Caldera, 22 km SW of their position at Tagus Cove.

Glow was visible over the NW end of the caldera, and a cloud was seen issuing from the same location after sunrise. The eruption was described as being smaller than the Volcan Wolf eruption of 1982 (see *SEAN Bulletin*, vol. 7, no. 8).

The TOMS instrument in the Nimbus 7 polar orbiting satellite detected SO<sub>2</sub> produced by the eruption April 1 and 2. No data were available March 30-31, and SO<sub>2</sub> had dropped below the detection threshold by April 5. Strongest values on April 1 were directly over the volcano, and a preliminary estimate of total SO<sub>2</sub> was 60,000 metric tons. No eruption cloud was evident on NOAA weather satellite imagery.

On the afternoon of April 4, the cruise ship *Santa Cruz* reported a long plume of vapor coming from the caldera, but apparently decreasing in size. They looked for glow over the volcano that night but reported none.

On April 11, Fernandina was climbed from the NW by David Day and L. Peterson, who reported an apparently inactive lava flow

News (cont. on p. 340)

reaching from the western side of the caldera (near the site of the major eruption of 1968) to the lake. At 0650 the next morning, Day and Peterson heard a noise "like a large landslide" from their camp near the western caldera rim. Within 30 s, they reached the rim in time to see what Day described as a "nue ardent" that had already moved from the vent area halfway to the lake. They left the rim, and observers from Punta Espinosa, 17 km to the NE, described an eruptive cloud rising at 0655 to an estimated height of about 7 km. At 0704, Day and Peterson were overtaken by an ash rain described as "raindrops with ash," and total darkness persisted until 0720. A thickness of 3 mm of tephra accumulated during that period at their rim camp. By 0725 it was clear enough to see into the caldera. Tephra covered the new lava on the caldera floor with the exception of an area a few hundred meters across in which molten

lava could be seen. Day and Peterson left the rim at 1030, and no further volcanism had been witnessed at the time of their radio report, at 1500 on April 13, from Punta Espinosa.

This is the sixth known eruption of Fernandina since the major explosive eruption and massive caldera collapse of 1968. The last eruption was not recognized in the Galapagos, but its products are visible in an aerial photograph taken March 26, 1982. From a 500-m-long circumferential fissure on the rim of the caldera, flows moved both inward (N) down the caldera wall and over a high topographic bench, and outward (S) where the flow ponded behind another row of circumferential vents. The eruption had yet taken place when Tom Simkin and others passed this area on December 4, 1980.

Information Contacts: Gundler Reck, Director, Charles Darwin Research Station, Isla Santa Cruz, Galapagos Islands, Ecuador; Luchio Maldonado, Metropolitan Touring, P.O.

Box 2542, Avenida Amazonas 230, Quito, Ecuador; David Day, Isla Santa Cruz, Galapagos Islands, Ecuador; Arlin Krueger, Code 963, NASA Goddard Space Flight Center, Green-

belt, MD 20771; Michael Matson, NOAA/NESDIS, Room 510, World Weather Bldg., Washington, DC 20233.

## Books

### Magnetic Reconnection in Space and Laboratory Plasmas

E. W. Hones, Jr.

Los Alamos National Laboratory, Los Alamos, NM 87545

AGU is publishing *Magnetic Reconnection in Space and Laboratory Plasmas*, as volume 30 of

the *Geophysical Monograph Series* (members \$23.10; nonmembers \$33.00). This volume is based on the Chapman Conference on Magnetic Reconnection, which was held at the Los Alamos National Laboratory in October 1983. Organization of that conference was first considered in early 1981, at a time when the body of evidence for the occurrence and importance of magnetic reconnection in earth's magnetosphere had already become impressive and was continuing to increase rapidly. There had not been a major conference on the subject since 1977, and the intervening

years had seen important new strides being made. Initial plans called for holding the conference in October 1982, but conflicts with other conferences forced its postponement for 1 year. The 1-year postponement turned out to be a blessing in disguise because it permitted major new magnetospheric observations, made during that year by the ISEE 3 satellite, to be reported at the conference.

ISEE 3 was launched in 1978 into a halo orbit around the sunward Lagrangian point where for the next 4 years it served as a solar wind monitor. In late 1982 it was transferred

to earth orbit where, by means of lunar gravity assist maneuvers, it executed several trajectories through the far magnetotail reaching down-tail distances as great as 220  $R_E$  (1.4  $\times 10^6$  km), about 3 times farther than systematic observations of the magnetotail had ever been made before (see *Eos*, 64, 929, 1983). Data returned from that distant tail location contained compelling new indications of the importance of the magnetic reconnection in the magnetosphere. One of the most remarkable of these was the observation of large plasmoids (plasma structures threaded with

to earth orbit where, by means of lunar gravity assist maneuvers, it executed several trajectories through the far magnetotail reaching down-tail distances as great as 220  $R_E$  (1.4  $\times 10^6$  km), about 3 times farther than systematic observations of the magnetotail had ever been made before (see *Eos*, 64, 929, 1983). Data returned from that distant tail location contained compelling new indications of the importance of the magnetic reconnection in the magnetosphere. One of the most remarkable of these was the observation of large plasmoids (plasma structures threaded with

CONTENTS	
HISTORICAL NOTE	THE RELATION OF FLUX TRANSFER EVENTS TO MAGNETIC RECONNECTION (A)
PREFACE	FLUX TRANSFER EVENTS AND INTERPLANETARY MAGNETIC FIELD CONDITIONS (A)
THEORY OF MAGNETIC RECONNECTION	SURVEY OF THE DISTRIBUTIONS IN FLUX TRANSFER EVENTS (A)
MAGNETIC FIELD RECONNECTION	P. M. Dally, M. A. Saunders, R. P. B. Jones, S. S. Kasper, and E. Scudder
SPONTANEOUS RECONNECTION	PATTERNS OF MAGNETIC FIELD RECONNECTION IN THE MAGNETOSPHERE (A)
FAST SPONTANEOUS RECONNECTION BY THE RESISTIVELY COUPLED MAGNETIC FIELD	J. G. Luhmann, R. J. Walker, C. T. Russell, H. D. Crocker, J. R. Spreiter, and S. S. Kasper
STUDY OF THE ASPECTS OF MAGNETIC FIELD LINE RECONNECTION	1982-3 PLASMA MEASUREMENTS IN THE LARGES OF THE DISTANT GEOMAGNETIC TAIL: IMPLICATIONS CONCERNING RECONNECTION AT THE INTERIOR MAGNETOPAUSE (A)
Y. M. Vasylunas	J. T. Gosling
MAGNETIC RECONNECTION AND MAGNETIC ACTIVITY	RECONNECTION IN EARTH'S MAGNETOTAIL
E. R. Farnett	RECONNECTION IN EARTH'S MAGNETOTAIL: AN OVERVIEW
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	A. B. Reiff
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	MAGNETOTAIL SHEET STRUCTURE AND THE VARIABILITY OF THE MAGNETOTAIL CURRENT SHEET
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	D. B. Fairfield
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	PLASMA SHEET BEHAVIOR DURING SUBSTORMS
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	Edward M. Hones, Jr.
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	STREAMING ELECTRIC FIELDS IN RECONNECTION EVENTS
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	John M. Blaser
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	PARTICLE AND FIELD SIGNATURES OF SUBSTORMS IN THE NEAR MAGNETOTAIL
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	D. M. Belcher
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	IMPLICATIONS OF THE 1980-82, 1979-80, AND 6 SUBSTORM EVENTS FOR THE ROLE OF MAGNETIC RECONNECTION IN THE GEOMAGNETIC TAIL
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	T. A. Fritz, D. M. Belcher, R. L. McPherson, and M. Lazarus
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	SUBSTORM ELECTRIC FIELDS IN THE EARTH'S MAGNETOTAIL
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	C. A. Gurnett and P. S. Hase
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	DIAGNOSTIC IONS AND ELECTRONS AND THEIR ACCELERATION PROCESSES IN THE MAGNETOTAIL
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	Harold G. Ockert
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	THE DISTANT GEOMAGNETIC TAIL: IN THEORY AND OBSERVATION
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	S. M. H. Cowley
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	ISEE 3 MAGNETIC FIELD OBSERVATIONS IN THE MAGNETOTAIL: IMPLICATIONS FOR RECONNECTION
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	S. S. Kasper, D. M. Belcher, J. A. Slavin, E. J. Smith, B. T. Tsurutani, and D. E. Jones
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	BOUNDARY LAYERS OF THE EARTH'S OUTER MAGNETOSPHERE
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	R. D. Ebert and L. A. Price
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	>5 keV ION OBSERVATIONS FROM ISEE-3 IN THE TAIL TAIL (A)
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	P. M. Dally, T. R. Sanderson, and K.-P. Wang
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	COMPUTER MODELING
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	THREE-DIMENSIONAL COMPUTER MODELING OF MAGNETIC RECONNECTION IN THE MAGNETOTAIL: PLASMA STRUCTURES IN THE NEAR AND DISTANT TAIL
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	John M. Blaser
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	EXTERNALLY DRIVEN MAGNETIC RECONNECTION
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	Raymond J. Walker and Tetsuya Sato
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	COMPUTER MODELING OF FAST COLLISIONLESS RECONNECTION
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	J. H. Lohr, P. Brunel, T. Tsurutani, J. Sato, C. G. Wu, and J. M. Dawson
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	THE NONLINEAR TEARING MODE
MAGNETIC RECONNECTION IN THE EARTH'S MAGNETOSPHERE	G. Van Hoven and R. S. Steinolfson

closed magnetic field loops moving very rapidly down the tail past the satellite in association with magnetospheric substorms. The plasmoids are thought to be sectors of the magnetotail plasma sheet that have been severed by magnetic reconnection occurring near the earth. That plasmoids are created and released during substorms had been inferred previously from satellite data acquired much closer to earth, so their actual observation with ISEE 3 constituted a most dramatic confirmation of that earlier idea. This phenomenon is depicted on the cover of this issue of *Eos* along with illustrations of analogous effects of magnetic reconnection that are seen in comets and that are produced in laboratory fusion experiments. The identification of the plasmoid phenomenon was made in ISEE 3 measurements of magnetic fields, energetic particles, and plasma. These and other ISEE 3 observations were reported for the first time at the conference and are published in the monograph.

This monograph is, I believe, the first book dedicated entirely to the subject of magnetic

reconnection and thus should satisfy the present need for a convenient and thorough source of information and references. There is good balance between review papers, papers presenting the basic principles of magnetic reconnection, and papers describing recent observational and theoretical advances. Although the book is weighted toward space plasma interests (e.g., planetary magnetospheres, comets, solar flares) there are also treatments of reconnection in laboratory plasmas, particularly in fusion research devices where a quite different view (in the words of V. M. Vasylunas, "a new view") of magnetic reconnection has traditionally been taken.

About a dozen of the papers presented at the conference had been, or were soon to be, submitted to journals for publication. To ensure completeness of coverage of the conference, extended abstracts of those papers, provided by the authors, have been included in the monograph. Two other features of the book will, I think, heighten reader interest. First, questions and answers recorded after the talks are included in the

text. Second, the final half-day summary and appraisal session of the conference was taped, and its transcript (with a minimum of necessary modification) is included as the last section of the book.

Finally, I am pleased that the book will serve to introduce to many of its readers the man who could appropriately be called the father of magnetic reconnection, the Australian physicist, Ronald G. Giovanelli. He was well known in the solar research community, but I feel that he probably was not known generally among magnetospheric and laboratory plasma physicists. Ron Giovanelli suggested the importance of magnetic neutral points in three pioneering papers in 1946, 1947, and 1948 in which he advanced a new theory of solar flares. The subsequent development of the concept of magnetic reconnection evolved from those works. He was invited to speak at the Los Alamos conference but could not attend because of a prolonged severe illness. Instead, he graciously sent me a videotape on which he presented the talk he had wanted to deliver in person. The tape

was played for the conference participants, and the talk is included in the monograph. Unfortunately, Ronald Giovanelli finally succumbed to his long illness in January 1984.

Edward W. Hones, Jr., received his Ph.D. in physics from Duke University in 1952. After working 7 years in nuclear reactor physics at the Argonne National Laboratory and the Savannah River Plant he became interested in space research, which he pursued at the Convair Corporation in San Diego, the Institute for Defense Analysis in Washington, D.C., the University of Iowa, and since 1966, at the Los Alamos National Laboratory. His primary space research interest has been the physics of the earth's magnetosphere. Using data from particle and plasma instruments developed by Los Alamos and for the Vela satellite and NASA's IMP

6, 7, and 8 satellites he did pioneering studies relating geomagnetic and auroral activity to the magnetosphere's dynamical behavior in the flowing solar wind. Those studies contributed importantly to the evolution of the present solar wind-magnetosphere interaction theory in which magnetic reconnection is a fundamental process. His magnetospheric studies continue through collaborations with several scientific institutions, most recently using improved observations with NASA's ISEE 1, 2, and 3 satellites.

## New Publications

Items listed in New Publications can be ordered directly from the publisher; they are not available through AGU.

**Developments in Soil Mechanics and Foundation Engineering, I, Model Studies.** P. K. Banerjee and R. Butterfield (Eds.), Applied Science, New York, xii + 266 pp., 1984, \$59.95.

**Dictionary of Petrology, S. I. Tomkieleff.** E. K. Walton, B. A. O. Randall, M. H. Batley, O. Tomkieleff (Eds.), John Wiley, 680 pp., 1983, \$100.

**English-Russian Dictionary of Applied Geophysics.** B. V. Gusev, N. N. Zefirov, A. S. Petukhov, I. K. Kupalov-Yaropolk, Pergamon, New York, x + 488 pp., 1984, \$30.

**Explosive Volcanism: Inception, Evolution, and Hazards.** Studies in Geophysics, National Academy Press, Washington, D.C., xii + 176 pp., 1984, \$24.50.

**Global Biogeochemical Sulphur Cycle: Scope 19.** M. V. Ivanov and J. R. Freney (Eds.), John Wiley, New York, xiv + 470 pp., 1983, \$61.95.

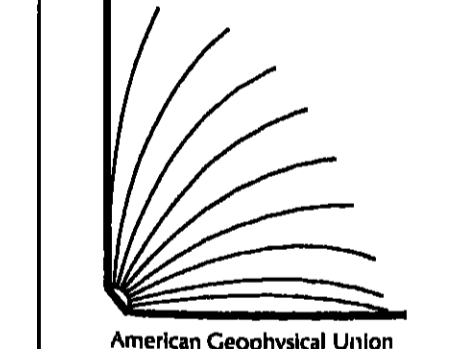
**Index of Earth Resources: Observation Systems (poster),** compiled by C. S. Southworth, U.S. Geological Survey, Reston, Va., no charge.

**Laser Remote Sensing: Fundamentals and Applications.** R. M. Measures, John Wiley, New York, xii + 510 pp., 1984, \$44.95.

**Politics of Mineral Resource Development in Antarctica: Alternatives Regimes for the Future.** W. E. Westmeyer, Westview, Boulder, Colo., xv + 267 pp., 1984, \$22.50.

**Proceedings of the Fifth Symposium on Polar Meteorology and Glaciology: Special Issue, No. 29.** K. Kusunoki (Ed.), National Institute of Polar Research, Tokyo, v + 227 pp., 1983.

## Yours For the Asking



## PUBLICATIONS CATALOG

1984  
Your own guide to AGU's current selection of books and periodicals. Contains brief descriptions, prices, and order forms.

For your free copy, write or call:

American Geophysical Union  
2000 Florida Ave., N.W.  
Washington, DC 20009  
Attn: Marketing Dept.  
(800) 424-2488

**AGU MEMBERS**

Tell your friends, colleagues, and students about AGU. Call 800-424-2488 for membership applications.

## Classified

**RATES PER LINE**  
**Positions Available, Services, Supplies, Courses, and Announcements:** first insertion \$3.00, additional insertions \$4.25.  
**Positions Wanted:** first insertion \$2.00, additional insertions \$1.50.  
**Student Opportunities:** first insertion free, additional insertions \$2.00.

There are no discounts or commissions on classified ads. Any type style that is not published is charged at general advertising rates. *Eos* is published weekly on Tuesday. Ads must be received in writing by Monday, 1 week prior to the date of publication.

Replies to ads with box numbers should be addressed to Box 200, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, DC 20009.

For more information, call 202-462-6903 or toll-free 800-424-2488.

### POSITIONS AVAILABLE

**Air Force Geophysics Laboratory Geophysics Scholar Program (1984-1988).** The Air Force Geophysics Laboratory (AFGL) and The Southern States Geophysics Laboratory (SSGL) announce that applications are invited for research appointments during the 1984-1985 year in the Geophysics Scholar Program. This program provides research opportunities of 10 to 12 months duration for selected Engineers and Scientists to perform research in residence at the AFGL, Hanscom AFB, near Boston, Massachusetts. Scholars will be selected primarily from such fields as Geophysics, Atmospheric Physics, Meteorology, Ion Chemistry, Applied Science, Mathematical Modeling using Computers, and Engineering.

To be eligible, candidates must have a Ph.D. or equivalent experience in an appropriate technical field. Some appointments may be confirmed from August 1984 so early applications are encouraged. All qualified applicants will receive consideration without regard to race, color, religion, sex, or national origin. Application Deadline for September Appointments: August 1, 1984. For further information and application forms contact: SCCEE, 1101 Massachusetts Avenue, St. Cloud, FL 32769 Telephone: (805) 892-6146.

SCCEE supports Equal Opportunity/Affirmative Action.

**Postdoctoral Fellow in Atmospheric Sciences.** A position will be available beginning October 1, 1984, for a postdoctoral fellow in the Department of Geophysics and Meteorology for theoretical analysis of the shuttle glow and studies of upper atmosphere physics and chemistry. A Ph.D. which involved research in aeronomy, is required. Send applications and names of three references to: A. Dalgaard, Center for Astrophysics, 60 Garden Street, Cambridge, MA 02138.

**Positions in Nuclear Waste Disposal Project.** Argonne, Illinois, location. The Project Management Division of Battelle Memorial Institute has immediate openings in its Office of Crystalline Repository Development for a Geohydrologist and a Geostatistician to work on the contract for the development of a high-level nuclear waste repository in deep crystalline rock formation.

**Geohydrologist.** Responsibilities include detailed multi-dimensional analysis of fluid flow, heat flow, solute transport and radiolabelled transport in multi-aquifer systems as part of the performance assessments of potential nuclear waste repository sites. Requirements include:

- M.S./Ph.D. in hydrology/related field.
- Experience in flow and transport modeling of large geohydrologic systems.
- Hands-on computer modeling and programming background.
- Excellent oral and written communication skills.

**Geostatistician.** Responsibilities include the development of sensitivity and uncertainty analysis methodology using Monte Carlo and Latin Hypercube) for existing computer codes of ground-water flow, radionuclide transport, and thermal, mechanical, and chemical processes; sensitivity and uncertainty analyses with respect to the performance assessments of potential nuclear waste repository sites; and geostatistical analyses (including kriging) of spatially distributed geologic and hydrologic data. Requirements include:

- M.S./Ph.D. in engineering/earth sciences/applied mathematics with strong statistical background
- Hands-on computer modeling and programming background
- Excellent oral and written communication skills.

We offer comprehensive benefits package and a salary commensurate with your background and experience. Send resume in confidence, to: Rosalind Drum

Battelle Project Management Division  
502 King Avenue  
Columbus, Ohio 43201.

An equal opportunity/affirmative action employer.

**Geoscience Data Manager and Staff/Texas A&M University.** Geoscience Data Manager and Staff, Ocean Drilling Program, Texas A&M University, to assemble and monitor all of the electronic film and paper data collections produced on the drilling vessel and during subsequent shore studies, including: data management, preparation of data syntheses and documentation, response to user requests and support of research activities. Geoscience bachelors or masters degree required. Experience in data management and computer programming is desirable. Send a letter of application, resume, names of three references, and other relevant information to: Dr. Russell Merrill, Curator and Manager of Science Services.

**Ocean Drilling Program.** P.O. Drawer GK, College Station, Texas 77843. Application deadline is June 1, 1984.

**Southwest Research Institute/Los Alamos Spectrometry.** A senior staff position is available in the Southwest Research Institute's Department of Space Sciences for a Ph.D. level experimental physicist to develop and operate a new mass spectrometer. The successful applicant will have the opportunity to develop a new mass spectrometer for space research and to participate in the development of a new mass spectrometer for space research. The position requires significant experience in magnetic ion mass spectrometry and in microchannel-plate imaging detector systems. Contact J. L. Burch, Southwest Research Institute, P.O. Drawer 28510, San Antonio, TX 78284, telephone 512-584-5111, extension 2526, or Bill Crummett, Personnel Department, extension 2072.

**Assistant Researcher/University of Hawaii.** The Hawaii Institute of Geophysics, Planetary Geosciences Division is accepting applications for one to three positions, full-time, federal funds, to begin between June 1, 1984 and January 31, 1985, for a postdoctoral fellow, a research assistant, and a research scientist. The incumbent(s) will develop and utilize physical remote measurements of planetary surfaces and laboratory measurements of appropriate materials to study the composition, structure, and physical processes operating and also evolution of planets, satellites, asteroids and comets. Emphasis is to be on optical spectroscopy and surface composition for asteroids, comets, Galilean satellites and terrestrial planets. The incumbent(s) is expected to develop an independent research program. MINIMUM QUALIFICATIONS: Ph.D. in earth and planetary sciences or a closely related field; experience in acquisition, processing and interpretation of multi-spectral and spectroscopic data; working knowledge of evolution and present state of the planets and of rock-forming minerals (including melt and their optical properties). DESIRABLE: Experience with electro-optical instrument development and operation, large array computer processing, spacecraft experiments and supervision of technical staff and graduate students. SALARY: Minimum \$20,000/annual maximum \$30,000/annual. INQUIRIES: Applicants should send a cover letter describing qualifications and experience with their vitae to: Dr. Thomas B. McCord, Planetary Geosciences Division, HIG University of Hawaii, 2525 Correa Road, Honolulu, Hawaii 96825. CLOSING DATE: September 30, 1984.

An Equal Opportunity Employer.

**Eastern Illinois University/Department of Geography & Geology Teaching Position in Geology.** The Department of Geography/Geology at Eastern Illinois University is accepting applications for a temporary one-year position in geology, beginning August 25, 1984. Candidates are very good that this position will become full-time tenure track. A Ph.D. is required. Rank will be at the assistant professor level. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic minerals, structure, hydrology, and field geology. The candidate will be expected to teach physical or historical geology. Preference will be given to those candidates who can teach one or more of the following: an introductory course in geophysics, economic

